

Original Research Article

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Bacteriological Profile and Antimicrobial Susceptibility Pattern of Indian Currency Circulating in a Tertiary Care Hospital of South India

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ABSTRACT

Currency in hospital is commonly contaminated with different pathogenic and potential pathogenic organisms and all people handling currency are invariably exposed to these microorganisms. To find the profile of bacteria on Indian currency and the antibiotic susceptibility pattern of the isolated bacteria. It was a prospective study from September 2014 to February 2015. A total of 200 currency notes of different denominations, taken from OPD registration counters, hospital pharmacy, laboratory technicians, doctors, nurses and other hospital staffs were analysed. Among the 200 currency notes of five different denominations 172 (86%) were found to be contaminated and 28 (14%) were sterile. A total of 214 organisms were isolated from 172 contaminated currency notes. Among the 214 isolates 106 (49.53%) were pathogenic and 108 (50.47%) were non-pathogenic organisms. Out of 214 isolates the percentage of Gram positive isolates were 186 (86.9%) and 28 (13.1%) were Gram negative bacilli. Among Gram positive cocci the most common isolate was *Enterococcus* 54 (25.2%) followed by *CONS* 48 (22.4%) and micrococci 30 (14.1%). Among Gram negative bacilli the most common isolate was *Pseudomonas aeruginosa* 14 (6.6%) followed by *Escherichia coli* 10 (4.7%). Among the currency notes of different denominations most of the organisms were present on 10 rupees note and 20 rupees note 50 (23.4%) followed by 50 rupees note 46 (21.5%). Minimum no of organisms were present on 500 rupees note 32 (14.9%). Among Gram positive isolates maximum susceptibility was seen against vancomycin and linezolid 126 (100%). Among the Gram negative isolates maximum susceptibility was seen against imipenem 28 (100%) followed by piperacillin – tazobactam 26 (92.8%). With the knowledge of the likely organisms isolated from currency notes and their resistance pattern, good money handling practices such as washing hands with soap and water before eating and avoiding using saliva during counting money can reduce risk of infection.

Keywords

Currency notes,
Bacteriological
profile, Antibiotic
susceptibility pattern

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Introduction

Currency is handled by all categories of people and may be contaminated during coughing, sneezing, touching with hands and placement on dirty surfaces. Many people

tongue-wet their fingers when counting money and contaminate their fingers as well as currency notes. So, it is obvious that gets on hands may be transferred to money and vice-versa (Pal *et al.*, 2013). The environment plays a critical role in transmission to humans, with

many environmental materials serving as vehicles. Microbial contaminants may be transmitted either directly, through hand-to-hand contact, or indirectly, via food or other inanimate objects like fomites. Paper currency offers a larger surface area as a breeding ground for pathogens. Microbes may persist on it for longer periods (Rote *et al.*, 2010; Al-Ghamdi *et al.*, 2011).

The isolates include *Bacillus cereus*, *Staphylococcus aureus*, *Coagulase negative staphylococcus*, *Klebsiella pneumoniae*, *Escherichia coli*. *Bacillus cereus* and *staphylococcus* are observed to be isolated from maximum number of currency notes (Tagoe *et al.*, 2011).

Bacteria are observed to be susceptible to ceftriaxone, gentamicin, norfloxacin and ofloxacin and vancomycin. Susceptibility to amoxicillin, penicillin, ampicillin and cotrimoxazole has been observed to be low (Akoachere *et al.*, 2014).

Contaminated fomites or surfaces play a key role in spread of bacterial infections with antimicrobial resistance. Antimicrobial resistance is a global phenomenon that has resulted in high morbidity and mortality as a result of treatment failures.

Studies of contamination of money with microbial agents is lacking in most developing countries. Shortage of information may contribute to the absence of public health policies regarding currency usage, handling and circulation.

Therefore the current study was designed to add to the limited body of literature on bacterial contamination of currency notes and the antimicrobial susceptibility pattern of the isolates. This will emphasize the risks associated with microbial contamination on currency notes while handling money.

Materials and Methods

It was a prospective study from September 2014 to February 2015 which included a total of 200 currency notes of different denominations, taken from OPD registration counters, hospital pharmacy, laboratory technicians, doctors, nurses and other hospital staffs working in BLDEA'S Shri B.M. Patil Medical College Hospital and Research Centre, Vijayapura.

Inclusion criteria

Single and mixed growth isolated from was included in the study.

Exclusion criteria

Anaerobic and fungal organisms were excluded from the study.

Currency of 10, 20, 50, 100 and 500 (forty each) were collected randomly without any special selection criteria. Persons handling the money were asked to deposit the currency in a sterile polythene bag. Samples collected were sealed, tagged and taken to the bacteriology laboratory for analysis. A sterile cotton swab soaked in normal saline was rubbed thoroughly on both surfaces of currency notes. Swabs were inoculated on nutrient agar, MacConkey agar and blood agar plates. Nutrient agar and MacConkey agar plates were incubated aerobically and blood agar plates were incubated in the presence of 5% CO₂ at 37°C overnight. The isolates were identified by gram staining, colony morphology and standard biochemical tests: catalase, slide and tube coagulase, oxidase, esculin hydrolysis, indole production, methyl red test, Voges-Proskauer test, citrate utilization (IMViC tests), H₂S production, ornithine decarboxylase, arginine hydrolase, lysine decarboxylase, urease, nitrate reduction and sugar fermentation tests (Collee and Marr,

2012). Antibiotic susceptibility tests were done on these isolates by standard Disc diffusion method according to CLSI guidelines. The following antibiotics were tested: For Gram positive cocci penicillin, azithromycin (15µg), cotrimoxazole (25µg), linezolid (30µg), tetracycline (30µg), ciprofloxacin (5µg), gentamicin (10µg), ampicillin (10µg), cloxacillin (10µg), cefuroxime (30µg) and vancomycin (30µg). For Gram negative bacilli ampicillin (10µg), gentamicin (10µg), amikacin (30µg), piperacillin-tazobactam (100/10µg), cefuroxime (30µg), cephalixin (30µg), ceftriaxone (30µg), cotrimoxazole (25µg), ceftazidime (30µg), tetracycline (30µg), ciprofloxacin (5µg) and imipenam (10µg).

Results and Discussion

Among the 200 currency notes of five different denominations 172 (86%) were found to be contaminated and 28 (14%) were sterile. The percentage of contaminated and sterile notes is given in (Table 1).

A total of 214 organisms were isolated from 172 contaminated currency notes. Among the 214 isolates 106 (49.53%) were pathogenic and 108 (50.47%) were non-pathogenic organisms. Non-pathogenic organisms included Coagulase negative *Staphylococcus* (CONS) 48 (22.4%) followed by micrococci 30 (14.1%) and Gram positive bacilli 30 (14.1%) Pathogenic organisms can cause disease in healthy host while non-pathogenic organisms can cause disease in immunocompromised host.

Out of 214 isolates the percentage of Gram positive isolates were 186 (86.9%) and 28(13.1%) were Gram negative bacilli. Among Gram positive isolates 156 (72.9%) were Gram positive cocci and 30 (14.1%) were Gram positive bacilli. Among Gram positive cocci the most common isolate was *Enterococcus* 54 (25.2%) followed by *CONS*

48 (22.4%) and micrococci 30 (14.1%). Among Gram negative bacilli the most common isolate was *Pseudomonas aeruginosa* 14 (6.6%) followed by *Escherichia coli* 10(4.7%) and *Klebsiella* species 4 (1.9%). Overall *Enterococcus* was the major organism isolated 54 (25.2%). The distribution of organisms is given in (Table 2).

Among the currency notes of different denominations most of the organisms were present on 10 rupees note and 20 rupees note 50 (23.4%) followed by 50 rupees note 46 (21.5%).

Minimum no of organisms were present on 500 rupees note 32 (14.9%). The distribution of organisms on currency notes is given in (Table 3).

Antimicrobial susceptibility pattern of Gram positive organisms

Among Gram positive cocci antimicrobial susceptibility testing was performed for pathogenic isolates and Coagulase negative *Staphylococcus*. Maximum susceptibility was seen against vancomycin and linezolid 126(100%) followed by tetracycline 102 (80.9%) and ciprofloxacin 98 (77.7%). Minimum susceptibility was seen against Penicillin 62 (49.2%) followed by ampicillin 64 (50.8%). Other effective drugs were cotrimoxazole 96 (76.2%), Gentamicin 94 (74.6%), azithromycin and cefuroxime 92 (73.1%).The susceptibility pattern of Gram positive isolates is given in table 4 and figure 1.

Antimicrobial susceptibility pattern of Gram negative organisms

Among the Gram negative isolates maximum susceptibility was seen against imipenam 28 (100%) followed by piperacillin – tazobactam 26 (92.8%) followed by amikacin 24 (85.7%).

Table.1 Percentage of contaminated and sterile notes

Currency	Rs 10	Rs 20	Rs 50	Rs 100	Rs 500	Total no (%)
Contaminated	38	36	36	34	28	172 (86%)
Sterile	2	4	4	6	12	28 (14%)

Table.2 Percentage of organisms isolated from currency notes

Organisms	No (%)
<i>Enterococcus species</i>	54 (25.2%)
<i>CONS</i>	48 (22.4%)
<i>Micrococci</i>	30 (14.1%)
Gram positive bacilli	30 (14.1%)
<i>Staphylococcus aureus</i>	24 (11.2%)
<i>Pseudomonas aeruginosa</i>	14 (6.5%)
<i>Escherichia coli</i>	8 (4.7%)
<i>Klebsiella species</i>	4 (1.9%)
Total	214

Table.3 Distribution of organisms on currency notes of different denominations

Currency denomination	Rs 10	Rs 20	Rs 50	Rs 100	Rs 500	Total
No of currency	40	40	40	40	40	
<i>Enterococcus sp</i>	12	12	14	8	8	54
<i>CONS</i>	10	14	12	6	6	48
<i>Micrococci</i>	8	10	2	6	4	30
<i>Gram positive bacilli</i>	6	6	8	6	4	30
<i>Staphylococcus aureus</i>	6	4	4	4	6	24
<i>Pseudomonas aeruginosa</i>	4	2	2	4	2	14
<i>Escherichia coli</i>	4	-	4	2	-	10
<i>Klebsiella species</i>	-	2	2	-	-	4
Total no (%)	50(23.4%)	50(23.4%)	46(21.5%)	36(16.8%)	32(14.9%)	214

Table.4 Antimicrobial susceptibility pattern of Gram positive isolates

Antimicrobial agent	<i>Enterococcus sp</i>	<i>CONS</i>	<i>S.aureus</i>	Total no (%)
Penicillin	30	26	6	62 (49.2%)
Azithromycin	40	36	16	92 (73.1%)
Cotrimoxazole	40	40	16	96 (76.2%)
Linezolid	54	48	24	126 (100%)
Tetracycline	42	40	20	102 (80.9%)
Ciprofloxacin	44	38	16	98 (77.7%)
Gentamicin	40	38	16	94 (74.6%)
Ampicillin	30	28	6	64 (50.8%)
Cloxacillin	38	36	16	90 (71.4%)
Cefuroxime	40	32	20	92 (73.1%)
Vancomycin	54	48	24	126 (100%)

Table.5 Antimicrobial susceptibility pattern of Gram negative isolates

Antimicrobial agent	<i>P.aeruginosa</i>	<i>E.coli</i>	<i>Klebsiella sp</i>	Total no (%)
Ampicillin	2	0	0	2 (7.14%)
Gentamicin	10	6	4	20 (71.4%)
Amikacin	12	8	4	24 (85.7%)
Cefuroxime	6	4	2	12(42.8%)
Cephalexin	6	4	2	12 (42.8%)
Ceftriaxone	8	6	2	16 (57.1%)
Ceftazidime	10	6	4	20(71.4%)
Cotrimoxazole	10	8	2	20 (71.4%)
Tetracycline	10	8	4	22 (78.6%)
Ciprofloxacin	10	8	2	20 (71.4%)
P+T	12	10	4	26 (92.8%)
Imipenem	14	10	4	28 (100%)

Fig.1 Antimicrobial susceptibility pattern of Gram positive isolates

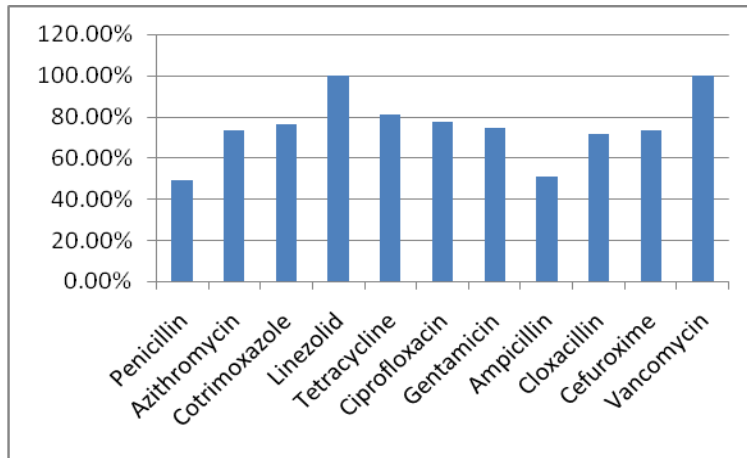
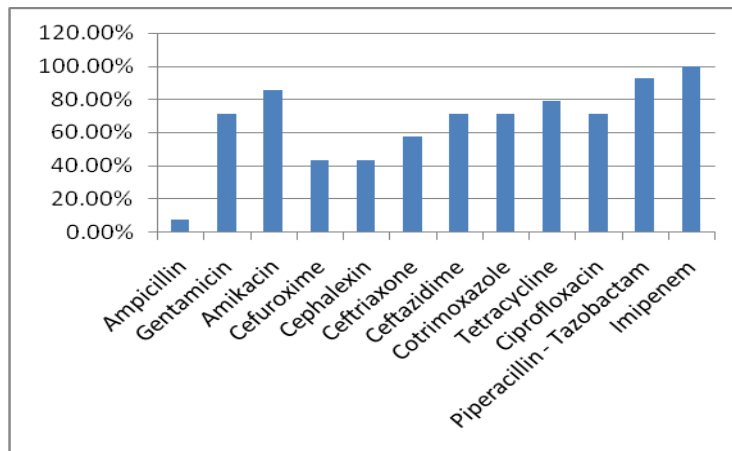


Fig.2 Antimicrobial susceptibility pattern of Gram negative isolates



Minimum susceptibility was seen against ampicillin 2 (7.14%) followed by cephalosporins like cefuroxime and cephalixin 12 (42.8%). Other effective drugs were tetracycline 22 (78.6%) followed by ciprofloxacin, gentamicin, cotrimoxazole and ceftazidime 20 (71.4%). The antimicrobial susceptibility pattern of Gram negative isolates is given in table 5 and figure 2.

In day to day use paper currency notes are transferred from one individual to another which transmits the microorganisms present on paper currency notes. In India even paper currency notes are poorly-handled. The major population of India does not carry money in wallets and squeezing of currency notes is a common occurrence (Sadavarte *et al.*, 2014). In the present study among the 200 currency notes of five different denominations 172 (86%) were found to be contaminated and 28 (14%) were sterile which is similar to other studies (Pal *et al.*, 2013; Sadavarte *et al.*, 2014).

Among the 214 isolates 106 (49.53%) were pathogenic and 108 (50.47%) were non-pathogenic organisms. Out of 214 isolates the percentage of Gram positive isolates were 186 (86.9%) and 28 (13.1%) were Gram negative bacilli. This is similar to the study conducted by (Pal *et al.*, 2013) where 95 % of the isolates were Gram positive but is in contrast with the study conducted by (Singh *et al.*, 2015) where majority of the pathogenic isolates were Gram negative.

Among Gram positive cocci the most common isolate was *Enterococcus* 54 (25.2%) followed by *CONS* 48 (22.4%) and micrococci 30 (14.1%). This is in accordance with the study conducted by (Pavani and Srividya, 2014) but is in contrast with the study conducted by (Mukhopadhyay *et al.*, 2015) where *Staphylococcus* was the most common Gram positive isolate.

Among Gram negative bacilli the most common isolate was *Pseudomonas aeruginosa* 14(6.6%) followed by *Escherichia coli* 10 (4.7%) and

Klebsiella species 4 (1.9%). This is in accordance with the study conducted by Mukhopadhyay *et al.*, (2015) but is in contrast with the study conducted by (Pal K *et al.*, 2013; Singh S *et al.*, 2015) where *Escherichia coli* was the most common Gram negative isolate. This discrepancy in bacterial pattern may be attributed to regional variation of bacterial profile, habits of the local people and also due to the fact that all the Indian studies done so far involve community set up and were not centered on hospitals. Presence of *Enterococci* is suggestive of significant fecal contamination of currency, and is a reflection of poor local environmental sanitation and personal hygiene. It also signifies a potential minefield for nosocomial infections.

Among the currency notes of different denominations most of the organisms were present on 10 rupees note and 20 rupees note 50 (23.4%) followed by 50 rupees note 46 (21.5%). Minimum no of organisms were present on 500 rupees note 32 (14.9%). The lower denomination currency notes are frequently circulated for daily activities where notes get tattered and dirty, therefore become more contaminated. Currency notes of both lower and higher denomination which were in poor conditions were more contaminated than notes those which were in good condition (Sadavarte *et al.*, 2014).

For Gram positive isolates maximum susceptibility was seen against vancomycin and linezolid 126(100%) followed by tetracycline 102 (80.9%) and ciprofloxacin 98 (77.7%). Minimum susceptibility was seen against Penicillin 62 (49.2%) followed by ampicillin 64 (50.8%). This pattern is similar to the study conducted by (Pavani and Srividya, 2014).

For Gram negative isolates maximum susceptibility was seen against imipenem 28(100%) followed by piperacillin – tazobactam 26 (92.8%) and amikacin 24 (85.7%). Minimum susceptibility was seen against ampicillin 2 (7.14%) followed by cephalosporins like cefuroxime and cephalixin

12 (42.8%). This pattern is in accordance with the study conducted by (Akoachere *et al.*, 2014). The isolation of bacterial agents including drug resistant organisms from currency notes confirms that currency might be a vector playing an important role in the transmission of pathogenic microorganisms, as well as in the spread of drug-resistant strains in the community.

In the present study among the organisms isolated from currency notes the most common Gram positive cocci was *Enterococcus* followed by *CONS*. Among Gram negative bacilli the most common isolate was *Pseudomonas aeruginosa* followed by *Escherichia coli*. For Gram positive isolates maximum susceptibility was seen against vancomycin and linezolid. For Gram negative bacilli maximum susceptibility was seen against imipenem followed by piperacillin – tazobactam. It can be concluded that currency in hospital is commonly contaminated with different pathogenic and potential pathogenic bacteria and all people handling currency are invariably exposed to these microorganisms. So awareness related to improvement of personal hygiene and good handling practices such as washing hands with soap and water before eating and avoiding using saliva during counting money are strongly recommended as the main pillar to reduce risk of infection.

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